ENVIRONMENTAL PROTECTION AGENCY WEATHER PROGRAMS

Environmental Protection Agency (EPA) is responsible for working with state, local, and other federal government agencies to provide user-appropriate and scientifically-credible air quality and meteorological programs to support regulatory applications. Applied research and meteorological support are furnished primarily by EPA's National Exposure Research Laboratory and EPA's Office of Air Quality Planning and Standards, both located in Research Triangle Park, North Carolina. This activity is provided through interagency agreements with the National Oceanic and Atmospheric Administration (NOAA), which assigns approximately 50 research meteorologists to the EPA.

Meteorological support to EPA's Office of Research and Development, EPA's Office of Air and Radiation, EPA Regional Offices, and to state and local agencies includes: (1) development and application of air quality dispersion models for pollution control, direct and indirect exposure assessments, and emission control strategy assessment; (2) preparation and performance of dispersion studies and air quality model evaluations; (3) review of meteorological aspects of environmental impact statements, state implementation plans, and pollution variance requests; (4) air quality forecasting; and (5) emergency response planning in support of homeland security. Meteorological expertise and guidance are also provided for the national air quality standards, modeling guideline, and policy development activities of the EPA.

In light of the 1990 Amendments to the Clean Air Act, air quality models and the manner in which they are used are expected to continue to grow over the next few years. In the area of pollutant deposition, the evaluation of nitrogen, oxidant, sulfur, and aerosol chemistries will help to clarify the roles of model formulation, cloud processes, radiative transfer, and air/surface exchanges in air quality model predictions, leading to a better understanding of model predictions relative to control strategy assessments. Further development and evaluation of existing air quality models will take place to accommodate the inter-pollutant effects resulting from the variety of control programs that are now or may be in place, such as the new National Ambient Air Quality Standards for ozone and particulate pollution. These inter-pollutant effects include trade-offs among controls on ozone, sulfur oxides, nitrogen oxides, and volatile organic compounds, as well as developing predictable methods of forecasting the impacts on various measures of air quality.

With respect to the fine particulate model development, dispersion models are being enhanced to accurately predict aerosol growth from precursors over local and regional transport distances. To assist in the evaluation of the contribution of various sources to regional air degradation, inert tracer and tagged species numerical models have been developed. These models will introduce separate calculations for inert or reactive chemical species emitted from a particular source or region. The calculations will proceed to simulate transport and transformation to a receptor point, where the contribution of emission sources can be discerned.

With respect to oxidant air quality modeling, the roles of biogenic volatile organic compounds, rural nitrogen oxides, and atmospheric transport are being elucidated. A better understanding will be developed of the fundamental aspects of the ozone non-attainment problem such as differences in urban and rural rates of and/or sources of photochemical production and the interaction through transport of these ozone precursors.

Atmospheric research in the areas of climate and climate change includes ozone distribution in the global troposphere, the relationship between aerosol loading and climate (including temporal and spatial aspects), regional climate studies addressing the interaction of climate with the biosphere, and the effects of climate change on regional air quality. The climatology program involves both analytical and statistical climatology as well as support for regional-scale climate model development.

Research in human exposure modeling includes micro-environmental monitoring and modeling, and development of exposure assessment tools. Micro-environmental algorithms are being developed based on field data to predict air quality in buildings, attached garages, and street canyons. These improved algorithms are then incorporated into micro-environmental simulation models for conducting human exposure assessments within enclosed spaces in which specific human activities occur.

In addition to the above major areas, dispersion models for inert, reactive and toxic pollutants are under development and evaluation on all temporal and spatial scales, e.g., indoor, urban, complex terrain, mesoscale, regional, and global. Other efforts include development of air pollution climatologies; modeling nutrient deposition to Chesapeake Bay and mercury deposition to the Florida Everglades; modeling of accidental releases of toxic

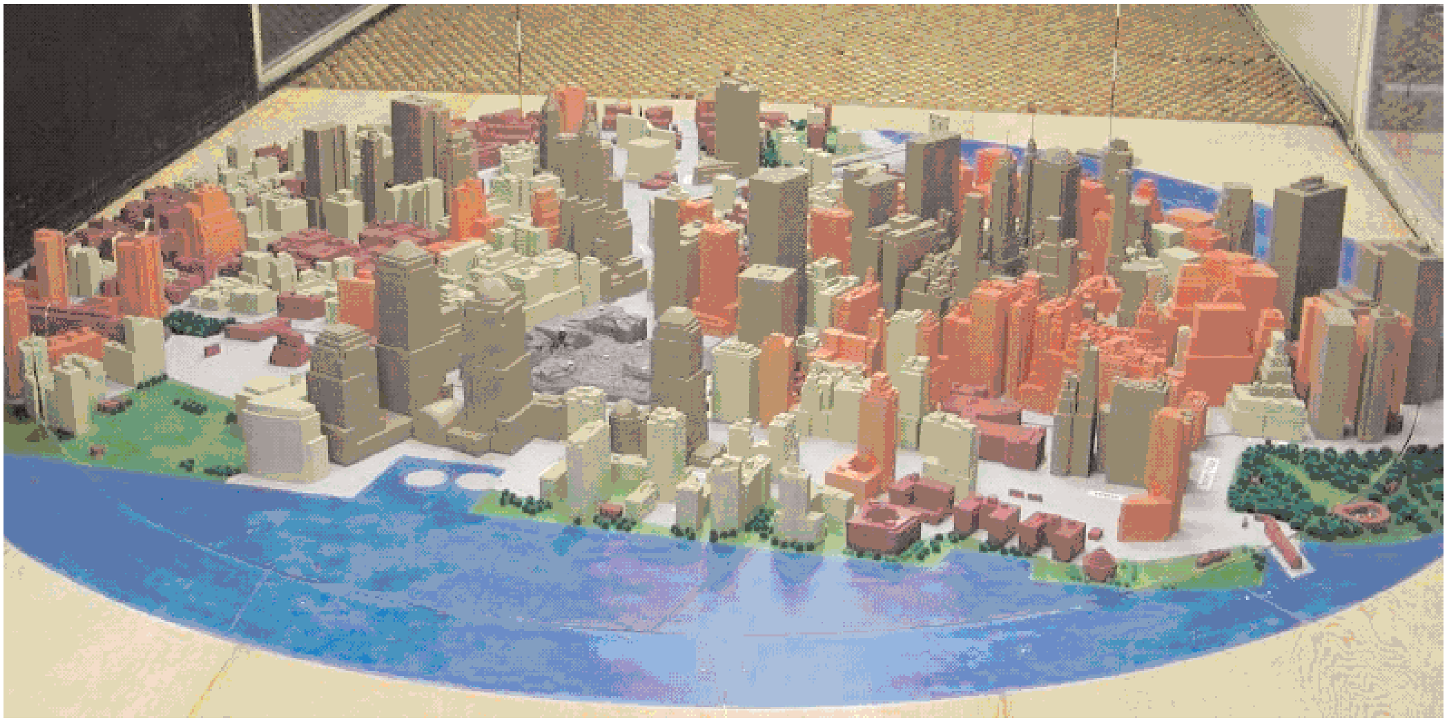

Figure 3-EPA-1. Model of lower Manhattan used to evaluate transport and dispersion of airborne agents in wind tunnel at EPA Fluid Modeling Facility.

compounds forming dense gas clouds; determination and description of pollutant effects on atmospheric parameters; and conversely, determination of meteorological effects on air quality. Atmospheric flow and dispersion experimental data obtained from wind tunnel and convection tank experiments in the EPA Fluid Modeling Facility will be used to continue development and evaluation of these models along with providing researchers with insight into the basic physical processes that affect pollutant dispersion around natural and man-made obstacles. For example, the transport and dispersion of airborne agents in the lower Manhattan, New York area are being simulated in the wind tunnel to evaluate Computational Fluid Dynamics modeling systems in an effort to help build confidence in modeling assessment source-receptor relationships for horrific events such as the one that occurred on September 11, 2001 (See Figure 3-EPA-1). Similar studies will be conducted for Mid-Manhattan, Washington, DC, and the Pentagon.

Over the past twenty-five years, numerous air quality simulation models have been developed to estimate reductions in ambient air pollutant concentrations resulting from potential emission control strategies. Separate models were developed, for example, for tropospheric ozone and photochemical smog, for acid deposition, and for fine particles. Distinct models also existed for addressing urban scale problems and the larger regional scale problems. It has been recognized, however, that the various pollutant regimes are closely linked chemically, spatially/temporally in the atmosphere. The principal purpose of the Models-3/Community Multi-scale Air Quality (CMAQ) modeling project was to develop a "one atmosphere" flexible environmental modeling tool that integrates the major atmospheric pollution regimes in a multi-scale, multi-pollutant modeling system. This system will enable high-level computational access to both scientific and air quality management users for socio-economic applications in community health assessments and ecosystem sustainability studies.

After seven years of development, the Models-3/CMAQ was first released in June 1998 and is being updated annually for use by Federal agencies, States, industry, and academia. The latest version of CMAQ, which includes science enhancements and computational efficiencies, was released in August 2004. It is also intended to serve as a community framework for continual advancement and use of environmental assessment tools. Models-3/CMAQ, configured for the Windows-NT computer system, is available on tapes from the National Technical Information Service (NTIS). It is accompanied by an Installation and Operations Manual, a User Manual, a Science Document, and a Tutorial providing step by step instructions for use of the modeling capabilities. Additional information is available at the Models-3 web site at *http://www.epa.gov/asmdnerl/models3/*. Figure 3-EPA-2 illustrates the results of Models-3/CMAQ for ozone and fine particulate matter (PM2.5), sulfates, and visibility for July 6, 1999 for the contiguous United States at 32-km horizontal grid dimension, a period of widespread ambient pollution in the

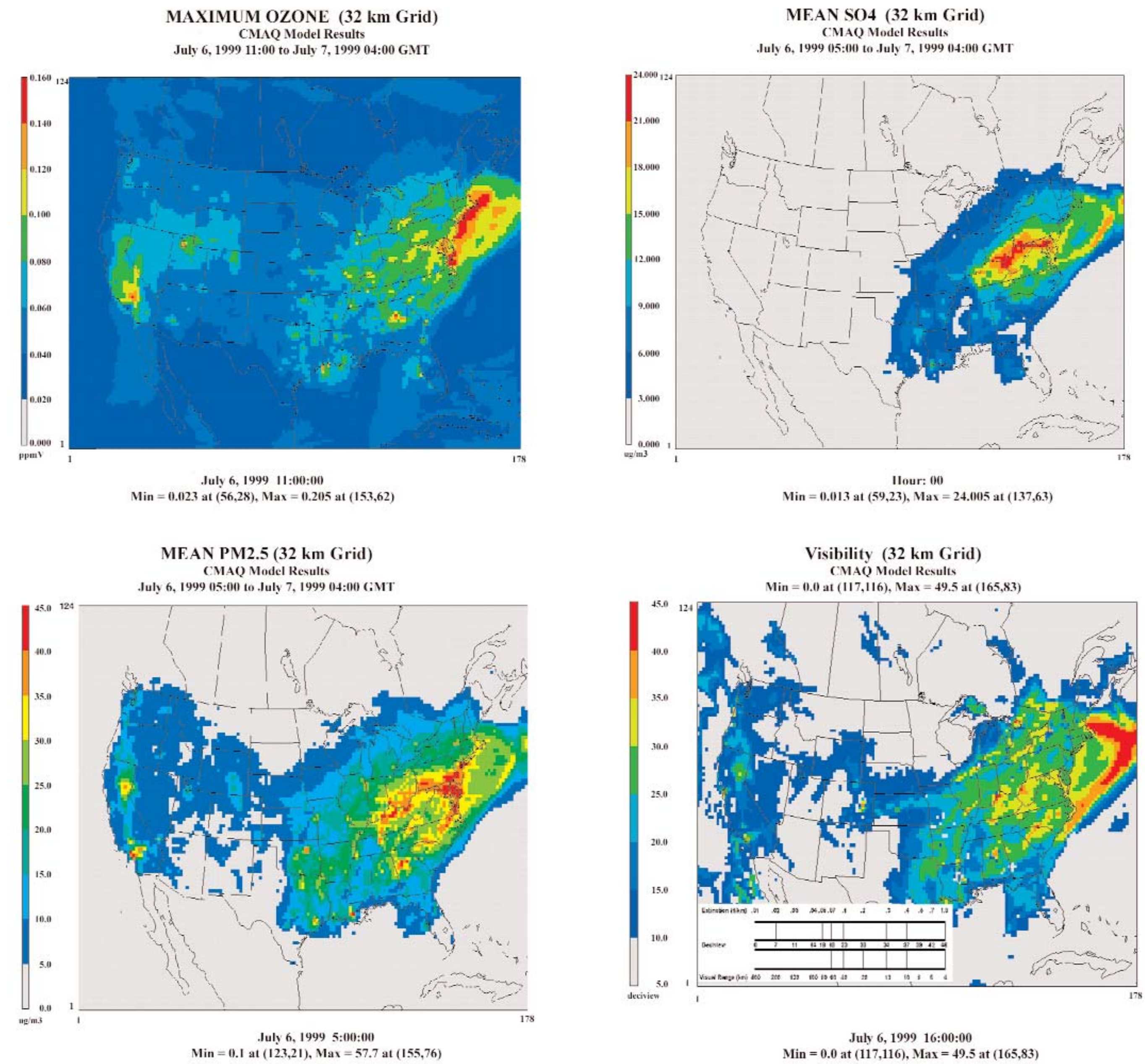

Figure 3-EPA-2. Models-3/CMAQ simulation results for July 6, 1999 for the contiguous United States at 32-km horizontal grid spacing showing: (upper left) maximum 1-hour average ozone concentration (ppmV) in each grid cell between 7:00 AM and midnight EDT; (upper right) 24-hour averages of sulfate concentrations (micrograms/m^3); (lower left) 24-hour averages of PM2.5 concentrations (micrograms/m^3) in each 32-km grid cell; and (lower right) noontime EDT visibility (deciview, note insert) in each grid cell.

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In FY 2004, EPA is working closely with the National Center for Environmental Prediction of the National Weather Service (NWS) in the development and use of a coupled meteorological-chemical transport model (Eta-CMAQ) for predicting ambient air quality over the continental United States. This capability is built on years of research in air quality, exemplified by the NOAA-led New England Pilot Air Quality Study in 2002 and 2004. In the first phase of the forecasting project, NWS is implement the Eta-CMAQ modeling system, to provide daily forecast guidance for ozone in the northeastern United States by September 2004. Within five years, the system for ozone will deploy nationwide. Within ten years, the operational forecast capability is projected to be able to forecast particulate matter. State and local air quality management agencies will continue to forecast local air quality, assisted in their efforts by the addition of national forecast guidance for the concentrations of ozone and other air pollutants.

EPA participation in the interagency

Information Technology Research and Development (IT R&D) Program is developing a modeling framework that supports integration of diverse models (e.g, atmospheric, land surface, and watershed) as part of EPA's Multimedia Integrated Modeling System (MIMS) project, described at *http://www.epa.gov/asmdnerl/mims/*. EPA's IT R&D work also enables increased efficiency in air quality meteorological modeling through research on parallel implementation of the CMAQ modeling system. The evolving MIMS research seeks to improve the environmental management community's ability to evaluate the impact of air quality and watershed management practices, at multiple scales, on stream and estuarine conditions. Toward this goal the primary objectives include (1) developing a prototype multiscale integrated modeling system with predictive meteorological capability for transport and fate of nutrients and chemical stressors; (2) enabling the use of remotely sensed meteorological data; and (3) developing a computer-based problem solving environment with ready access to data, models, and integrated visualization and analysis tools for water and air quality management, local and regional development planning, and exposure-risk assessments. Under the MIMS project, a variety of research areas are being pursued such as the integration of the National Weather Service Next Generation Radar (NEXRAD) Stage IV data into watershed modeling applications; enhanced atmospheric dry deposition models; multi-scale, spatially explicit watershed modeling tools; and model-coupling technology for integrating media specific models. The MIMS development extends the open architecture approach demonstrated in the third generation modeling system, Models-3/CMAQ, and is the next generation of modeling frameworks under the IT R&D program.

EPA also maintains relations with foreign countries to facilitate exchange of research meteorologists and research results pertaining to meteorological aspects of air pollution. For example, agreements are currently in place with Canada, Japan, Korea, China, and Mexico, and with several European countries under the NATO Committee on the Challenges of Modern Society (CCMS).